Observations on the Embryology of Insects and Arachnids. By A. T. Bruce.

The work, of which a short abstract is here given, comprises observations extending over a period of nearly two years.

A more detailed and illustrated account now in course of preparation will, it is hoped, show that if these observations have not brought to light anything absolutely new they have at least thrown additional light on several important questions in insect embryology.

With insect-eggs, the opacity of which renders them unsuitable for superficial observation, the sectional method leads to the best results. This method was followed in these investigations.

The important points to be determined in insect embryology are the segmentation of the egg and the formation of the blastoderm, the origin of the embryo and embryonic membranes, the formation of the germinal layers, metameric segmentation and all connected with it, including number of appendages, nerves, ganglia, &c.

The embryology of Arachnids, or at least of spiders, shows many points of resemblance to the embryology of insects. The first trace of the spider-embryo, the so-called primitive cumulus, is not unlike the early embryo of the Orthoptera. In the head region of the advanced spider-embryo are folds which very closely resemble the amniotic folds of the insect-embryo.

The insects studied included representatives from the Lepidoptera, Coleoptera, and Orthoptera, while a few incomplete observations were made on the embryology of the Neuroptera and on the maturation of the ovum in *Musca*.

The eggs of the spiders studied probably belonged to several species.

The embryology of *Thyridopteryx ephemeræformis*, or the common bag-worm, was carefully studied. Owing to abundance of material its development was followed from the early stages of segmentation to the advanced embryonic stage.

The segmentation of the egg of *Thyridopteryx* corresponds to that of the Lepidopterous insect described by Bobretzky. It can hardly be called a centrolecithal segmentation, inasmuch as in the earliest stages cells are found, not at the surface surrounding a central yolk-mass, but lying in the yolk, whence they migrate to the surface to form the blastoderm.

In *Thyridopteryx* it appears that some of the primitive embryonic cells never reach the surface, but remain as yolk-cells, round each of which, in the later stages of embryonic development, an aggregate of yolk-spherules occurs, and thus are formed the yolk-balls or segments.

In the grasshopper, however, there is a stage in which all the undifferentiated cells are apparently at the surface, while the yolk is arranged in pyramids corresponding to the yolk-pyramids of *Artocus*.

In *Meloë*, the species of beetle studied, probably a corresponding stage occurs in which all the cells are at the surface, though there are no yolk-pyramids; consequently, in the grasshopper and in *Meloë* the yolk-cells probably arise by delamination from the cells investing the yolk.

The embryo of *Thyridopteryx* and of other insects studied arises as a thickening on the surface of the egg not unlike the primitive cumulus of spiders.

The amniotic folds arise as folds of blastoderm on all sides of the embryo, and finally meet and unite over the median line of the ventral plate; consequently the embryo (described as the ventral plate at this stage) comes to lie in the yolk covered by the inner amniotic fold or true amnion, while the outer fold or serosa remains continuous with the blastoderm. The embryonic membranes of *Mantis* and *Meloë* arise in a quite similar manner. Brandt has described a different mode of origin for the embryonic membranes of the Neuroptera and Hemiptera.

After the formation of the membranes in *Thyridopteryx*, but synchronously with the same in *Mantis* and *Meloë*, an ingrowth occurs in the middle line of the embryo, which is partly a delamination and partly an invagination. By this ingrowth is formed the inner germ-layer, which in *Thyridopteryx* certainly corresponds to both mesoderm and endoderm. The yolk-cells do not appear to take any part in the formation of the endoderm in *Thyridopteryx*. Tichomiroff, from his studies in the Lepidoptera, comes to a similar conclusion in regard to the yolk-cells.

The yolk-cells of the grasshopper also appear to take no part in the formation of the endoderm.

The amnion in *Thyridopteryx* grows dorsally more rapidly than the body-walls and its opposite folds unite dorsally before the body-walls can grow together. Consequently the amnion in this insect forms part of the dorsal surface of the body, while for a time the entire embryo is enclosed as in a sack by the outer fold of the true amnion, which does not take part in the closure of the dorsal surface.

No dorsal organ corresponding to that described by Brandt for the Neuroptera was observed in *Thyridopteryx* or in the other insects studied. The amnion of the grasshopper does not apparently form any considerable portion of the dorsal wall of the body.

The nervous system arises in all insects studied as two ectodermic strings lying on each side of the blastopore, as the median line where the inner layer arises may be called. It subsequently divides into a number of ganglia corresponding to the somites of the body. The supraœsophageal ganglion, as good longitudinal sections of the *Thyridopteryx*-embryo show, consists of two portions—a posterior portion which innervates the paired labium, and the anterior portion which supplies the antennæ with nerves. The circumœsophageal commissure is formed by a portion of the posterior division of the supraœsophageal ganglion and a portion of the mandibular division of the subœsophageal ganglion. The supraœsophageal ganglion of

Thyridopteryx has its halves united by a double commissure, one portion crossing above and the other below the œsophagus. When the nervous system has been separated from the superficial ectoderm, a median ingrowth of ectoderm occurs in *Thyridopteryx* between the nerve-cords. The cells composing this ingrowth elongate and lie close to the nerve-cords.

At this stage it appears as if this median ingrowth were uniting the cords and forming a commissure, as Hatschek claimed for the Lepidoptera studied by him. This, however, does not prove to be the case. In a subsequent stage the elongated epithelial cells undergo division and give rise to migratory cells corresponding to other migratory mesoderm cells. Cells of this nature invest the nervous system, forming its peritoneal coat, but take no part in the formation of its commissure. The three pairs of thoracic limbs are conspicuous from their size in all embryos studied.

In the grasshopper both maxillæ have two lobes outside of and at the base of the main axis of the appendage. These recall, though they are probably not homologous with, the exopodites and epipodites of the Crustacean appendage. Similar lobes have been described by Patten for the maxillæ of *Blatta*. Tracheal invaginations occur in the maxillary segments of the grasshopper. In conclusion, it remains to mention an interesting stage of the spider-embryo in which an abdominal appendage is being converted by a process of invagination into a lung-book.—*Johns Hopkins University Circulars*, no. 49, May 1886, p. 85.

Notes on the Embryology of the Gasteropods. By J. Playfair McMurrich.

In a number of the 'Studies from the Biological Laboratory,' which will appear during the coming summer, I intend publishing a detailed and illustrated account of the results of my studies during the past winter upon the development of some marine Prosobranch Gasteropods. In the meantime, however, it is desirable that a brief abstract of some of the more important results should be presented.

The forms studied principally were *Fulgur carica* and *Fasciolaria tulipa*. The former furnished material for the earlier stages of development, while of the latter I studied only the more advanced embryos. The modes of segmentation of a few other forms, such as *Purpura floridana*, *Crepidula*, and *Eupleura caudata*, were also observed.

The first portion of my paper will deal with the ovum and the nutrition of the embryo, the non-development and employment as nutrition of the majority of the ova in each capsule of *Fasciolaria* being described and compared with other phenomena of a similar kind. In *Purpura floridana* a certain number of the ova, after segmenting regularly for some time, break down, and are employed as food by the survivors; in *Crepidula* we see the same process, but in a much less marked degree; while in *Neritina* it is carried to a greater extent, only one egg, out of a great number which, in each